(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 048 268 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
20.04.2005 Bulletin 2005/16

(51) Int Cl.[7]: **A61B 6/02**, H05G 1/38

(21) Application number: **00303521.9**

(22) Date of filing: **26.04.2000**

(54) Image sensing system

Bildaufnahmevorrichtung

Dispositif de prise de vues

(84) Designated Contracting States:
DE FR GB IT NL

(30) Priority: **27.04.1999 JP 11962999**

(43) Date of publication of application:
02.11.2000 Bulletin 2000/44

(73) Proprietor: **CANON KABUSHIKI KAISHA**
Tokyo (JP)

(72) Inventor: **Yamayoshi, Junichi**
Ohta-ku, Tokyo (JP)

(74) Representative:
Beresford, Keith Denis Lewis et al
BERESFORD & Co.
16 High Holborn
London WC1V 6BX (GB)

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a sensing system using a plurality of sensor units, and a sensor unit used in the sensing system.

Related Background Art

[0002] X-ray sensing aiming at medical diagnosis is often done using a film screen system which combines intensifying screen and an X-ray radiographic film. According to this method, X-rays transmitted through an object contain the internal information of the object. This information is converted into visible light proportional to the intensity of the X-rays by the intensifying screen. The X-ray radiographic film is exposed to the light, and an X-ray image is formed on the film.

[0003] Recently, digital X-ray image sensing apparatuses are becoming popular in which X-rays are converted into visible light proportional to the intensity of the X-rays by a phosphor, the light is converted into an electrical signal using a photoelectric conversion element, and the signal is converted into digital data by an A/D conversion circuit.

[0004] In a sensing room for general X-ray image sensing, normally, an upright stand for a thoracic portion and a table for an abdominal portion or a leg are prepared to cope with all target sensing portions, using a cassette together. After sensed on the upright stand, the patient moves to the table for the next required sensing. At this time, the X-ray technician supports and positions the patient to prepare for appropriate sensing. After positioning, the X-ray technician goes back to the operation room to radiate X-rays. When a film screen system is used, the patient must wait after sensing until film development is ended. After confirming upon development that normal sensing has been performed, the next sensing operation starts. To the contrary, when a digital X-ray sensing apparatus is used, the X-ray technician positions the patient and then returns to the operation room to radiate X-rays. The resultant X-ray image can be confirmed on the display monitor in several seconds. Hence, the X-ray technician can immediately start the next sensing.

[0005] Fig. 1 shows a conventional scheme of general sensing using a digital X-ray sensing apparatus. An upright stand 9 having a sensor unit 3 is prepared in a sensing room and connected to a control section 7 in an operation room. An X-ray technician appropriately positions a patient 2 in front of the upright stand 9 first. The X-ray technician returns to the operation room and presses an X-ray radiation switch. X-rays are radiated from an X-ray generation apparatus 1 and transmitted through the patient 2. The X-rays with the internal information of the patient 2 become incident on the sensor unit 3. A solid-state image sensing apparatus 4 in the sensor unit 3 is constructed by bonding a phosphor 5 for converting X-rays into visible light proportional to the intensity of the X-rays to a photoelectric conversion apparatus 6 for converting the visible light into an electrical signal proportional to the light intensity. The X-ray image data converted into an electrical signal by the photoelectric conversion apparatus 6 is A/D-converted, transferred to the control section 7 as digital data, and displayed on display sections 8 and 10. Since several seconds are normally required from X-ray radiation to image display, the X-ray technician enters the sensing room to attend the patient 2 immediately after X-ray radiation and confirms the image on the display section 10.

[0006] In this prior art, since the apparatus has only the thoracic sensor unit, only the information of the thoracic portion of the patient is obtained. To obtain information except the thoracic information, e.g., abdominal information, an abdominal sensor unit must be prepared in the sensing room independently of the thoracic sensor unit.

[0007] When the apparatus has the thoracic and abdominal sensor units, the information of the thoracic portion of the patient is obtained first. Then, the patient moves to the abdominal sensor unit to obtain abdominal information.

[0008] At this time, the abdominal sensor unit must transit from the sleep state (low current state) in the nonuse mode to the ready state (normal current state). Normally, the photoelectric conversion apparatus 6 in the sensor unit requires several seconds for the transit period in which the ready state is set. For this reason, the next sensing cannot be started during this time. When the thoracic sensor unit and abdominal sensor unit are simultaneously set in the ready state, the problem of wait time can be avoided. However, the service life of the solid-state image sensing apparatus normally becomes short in inverse proportion to the ready-state time.

[0009] GB2003010 discloses an X-ray generator assembly comprising a group of various X-ray devices which are selectively connected, one at a time, to a power supply unit by a switch. An operator presses a device selection key located on the central control desk to select one of the X-ray devices, and the power supply unit is then switched to supply power to a radiator of the selected X-ray device in order to effect X-ray examination. However, such a system does not overcome the problems set out above as a sensor unit will still require a transit period in which the ready state is set.

SUMMARY OF THE INVENTION

[0010] It is an object of the present invention to switch, in a sensing system having a plurality of sensor units, between the sleep state (or power-OFF state) and the

ready state (or a power-ON state) of each sensor unit at an effective timing.

[0011] In order to achieve the above object, according to an aspect of the present invention, there is provided a sensing system comprising a plurality of sensor units each including a respective photoelectric conversion apparatus, a plurality of selection means arranged in correspondence with said plurality of sensor units, respectively for selecting the corresponding respective sensor units, and control means for monitoring signals from respective selection means, wherein said control means, in response to a signal from any selected one of said plurality of selection means, arranged in correspondence with its respective selected sensor unit, is adapted to transmit to that respective sensor unit a command to switch the respective photoelectric conversion apparatus from a non-use mode of operation to a use mode of operation, and to transmit to another sensor unit, the photoelectric conversion apparatus) of which is in a use mode of operation, a command to switch that photoelectric apparatus from use mode of operation to non-use mode of operation.

[0012] Other objects, features, and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a view showing a prior art;
Fig. 2 is a view showing the first embodiment of the present invention;
Fig. 3 is a view showing the first embodiment of the present invention;
Fig. 4 is a view showing the second embodiment of the present invention;
Fig. 5 is a view showing the second embodiment of the present invention;
Fig. 6 is a view showing the second embodiment of the present invention; and
Fig. 7 is a view showing the third embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] The first embodiment of the present invention will be described with reference to Figs. 2 and 3.

[0015] Fig. 2 is a view for explaining a sensing system. Fig. 3 is a view showing details of the control section of the sensing system shown in Fig. 2. Referring to Fig. 2, an upright stand 9 and table 11 each having a sensor unit are prepared in a sensing room and connected to a control section 7 in an operation room. A patient 2 stands first in front of the upright stand 9 and is appropriately positioned. An X-ray technician returns to the operation room and presses an X-ray radiation switch. X-rays are radiated from an X-ray generation apparatus 1 and transmitted through the patient 2. The X-rays having internal information of the patient 2 become incident on the sensor unit 3. The sensor unit 3 includes a solid-state image sensing apparatus constructed by bonding a phosphor 5 for converting X-rays into visible light proportional to the intensity of the X-rays to a photoelectric conversion apparatus 6 for converting the visible light into an electrical signal proportional to the light intensity. The photoelectric conversion apparatus requires several seconds for the transit period in which the apparatus shifts from the sleep state (low current state) in the non-use mode to the ready state (normal current state). The X-ray image data converted into an electrical signal by the photoelectric conversion apparatus 6 is A/D-converted, transferred to the control section 7 as digital data, and displayed on display section 8 in the operation room and display section 10 in the sensing room. Since several seconds are normally required from X-ray radiation to image display, the X-ray technician enters the sensing room to attend the patient 2 immediately after X-ray radiation and confirms the image on the display section 10. If the X-ray image is normal, the X-ray technician presses a switch 14 as a selection means attached to the side surface portion of the sensing table 11. The X-ray technician positions the patient 2 to prepare for sensing on the table 11. The state of the switch 14 is monitored by the control section 7. When the switch 14 is pressed, the upright stand 9 is set in the sleep state, and the sensing table 11 is shifted to the ready state. Each of the switches 13 and 14 has a lamp indicating the state of the sensor. The lamp of the switch 13 is OFF. The lamp of the switch 14 blinks when the sensor is transiting to the ready state, and is turned on in the ready state. A transit time of several seconds is required until the ready state is set, as described above. However, the ready state is set while the patient is being positioned. The X-ray technician returns to the operation room and immediately switches the X-ray radiation switch to sense an image.

[0016] The control section 7 shown in Fig. 2 will be described next in detail with reference to Fig. 3. In the control section 7, a signal SW_sg1 from the switch 13 can be simultaneously input to an input buffer B11 21 connected to a data bus 28 of a CPU 26, and an interrupt controller ICNT 25. A signal SW_sg2 from the switch 14 can also be simultaneously input to an input buffer B12 23 connected to the data bus 28 of the CPU 26, and the interrupt controller ICNT 25. The interrupt controller ICNT 25 monitors these signals and, when one of the signals is enabled, generates an interrupt signal INT_sg to the CPU 26. The CPU 26 reads the input buffer B11 21 and input buffer B12 23 on the data bus, thereby determining the pressed switch. In this example, since the switch 14 is pressed, the CPU 26 detects the signal SW_sg2. A command for setting the sleep state is transmitted from a serial IF controller SC1 22 connected to

the data bus 28 to the sensor unit 3 through a command line Cmd1. In addition, a command for setting the ready state is transmitted from a serial IF controller SC2 24 to a sensor unit 17 through a command line Cmd2.

[0017] In this embodiment, two sensor units are used. However, three or more sensor units may be used.

[0018] The switch 14 is located on the side surface of the table 11. However, the switch 14 can be located at an optimum portion in accordance with the sensing operation of the X-ray technician who uses this switch.

[0019] In the above embodiment, a sensor unit in the nonuse mode is set in the sleep state, and that in the use mode is set in the ready state. However, a sensor unit in the nonuse mode may be set in a power-OFF state, and that in the use mode may be set in a power-ON state.

[0020] The second embodiment of the present invention will be described with reference to Figs. 4, 5, and 6.

[0021] Fig. 4 is a view for explaining a sensing system. Fig. 5 is a view showing details of the X-ray generation apparatus of the sensing system. Fig. 6 is a view showing details of the control section of the sensing system.

[0022] The operation of the second embodiment is the same as that of the first embodiment except that sensor units incorporate phototimers 15 and 16, respectively, and the sensing time can be controlled in accordance with the X-ray dose.

[0023] In general X-ray sensing, an image is normally sensed using an AEC (Auto Exposure Control) function of automatically adjusting the X-ray dose. AEC is also called a phototimer. In the phototimer, a phosphor is mounted on an element having a photoelectric effect and made to generate charges proportional to X-rays. When the charges reach a predetermined amount or more, a signal for cutting off the X-rays is output to the X-ray generation apparatus. As an element having a photoelectric effect, a semiconductor element such as a photodiode can be used. There is also a device which extracts visible light from a phosphor by a fiber and amplifies the light using a photomultiplier. The phototimers are connected to an X-ray generation apparatus 1, which is connected to a control section 7 such that they can communicate with each other. The control section 7 transfers a command to the X-ray generation apparatus 1 to switch between the phototimers 15 and 16 simultaneously with switching the sensor unit. The control section of this embodiment has a serial IF controller SC3 27 connected to a data bus 28, unlike the control section of the first embodiment, to transmit a command for switching between the phototimers 15 and 16 to a command line Cmd_X, as shown in Fig. 6. The X-ray generation apparatus 1 controls the X-ray generation timing in accordance with the output from the selected phototimer.

[0024] As shown in Fig. 5, the X-ray generation apparatus 1 receives the switching request command for the phototimer 15 through the command line Cmd_X from the control section 7. A CPU 32 receives the command through a serial IF controller SC 31 and switches a multiplexer MUX 34 in accordance with the output signal from an output register B 33, thereby switching the signal of the phototimer from Photo_s1 to Photo_sg2. The output from the multiplexer MUX 34 is compared with a predetermined voltage Vcmp by a comparator CMP 35. When the output from the multiplexer MUX 34 is equal to or larger than the voltage Vcmp, a relay driving circuit Dr 36 disconnects a relay R 37 for ON/OFF-controlling X-ray generation.

[0025] The third embodiment of the present invention will be described with reference to Fig. 7.

[0026] In this embodiment, each of sensor unit changeover switches 13 and 14 described in the first and second embodiments is connected to a control circuit 44 belonging to the photoelectric conversion apparatus in the sensor unit. As shown in Fig. 7, the line of a switch 20 is connected to an input register B1 41 connected to the data bus of a CPU 43, so the CPU 43 can monitor the state of the switch 20. When the switch 20 is pressed, and the CPU 43 detects it, the CPU 43 writes a signal representing it in an output register B2 42 connected to a data bus 45. The output from the output register B2 42 is connected to a control section 7 of the main body together with an image data line 46 for sending image data. The control section 7 is requested to switch the sensor unit having the pressed switch 20 to the ready state.

[0027] In the systems of the first to third embodiments, a child patient may accidentally press the switch 13, 14, or 20 in his or her reach. As a measure against this situation, switch enable and disable items of an X-ray sensor unit are provided in the user interface section of the control section 7, and the switch 13 or 14 is disabled as needed.

[0028] As has been described above, when a sensor unit selection means is prepared in correspondence with each sensor unit, for example, the X-ray technician can switch the sensor unit at an effective timing, and an efficient sensing sequence can be realized.

[0029] Many widely different embodiments of the present invention may be constructed without departing from the scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

Claims

1. A sensing system comprising:

   a plurality of sensor units (3,17) each including a respective photoelectric conversion apparatus (6);

   a plurality of selection means (13,14) arranged in correspondence with said plurality of sensor units, respectively for selecting the correspond-

ing respective sensor units; and
control means (7) for monitoring signals (SW_sg1, SW_sg2) from respective selection means (13,14);

wherein said control means (7), in response to a signal (SW_sg1; SW_sg2) from any selected one (13;14) of said plurality of selection means (13,14), arranged in correspondence with its respective selected sensor unit (3;17), is adapted to transmit to that respective sensor unit (3;17) a command (Cmd1; Cmd2) to switch the respective photoelectric conversion apparatus from a non-use mode of operation to a use mode of operation, and to transmit to another sensor unit (17;3), the photoelectric conversion apparatus (6) of which is in a use mode of operation, a command (Cmd2; Cmd1) to switch that photoelectric apparatus from use mode of operation to non-use mode of operation.

2. A system according to claim 1, wherein said control means (7) is arranged to set said respective selected sensor unit (3;17) to a power-ON state in the use mode of operation wherein said respective selected sensor unit (3;17) is supplied with power and to set said another sensor unit (17;3) to a power-OFF state in the non-use mode of operation wherein said another sensor unit (17;3) is not supplied with power.

3. A system according to claim 1, wherein said control means (7) is arranged to set the photoelectric conversion apparatus to a normal current state in the use mode of operation and to a low current state in the non-use mode of operation.

4. A system according to any preceding claim, further comprising electromagnetic wave generation means (1) for irradiating said respective selected sensor unit (3;17) with an electromagnetic wave, and wherein the generation time of the electromagnetic wave is controlled in accordance with the electromagnetic wave dose.

5. A system according to claim 4, wherein each of said plurality of sensor units comprises a phototimer (15,16) which outputs a signal to said electromagnetic wave generation means (1) and wherein said electromagnetic wave generation means (1) is operable to turn off generation of the electromagnetic wave in accordance with the signal amount of said output signal.

6. A system according to claim 5, wherein said control means (7) comprises means for selecting the phototimer (15,16) of said respective selected sensor unit (3;17).

7. A system according to any preceding claim, wherein said control means (7) comprises means for switching each of said plurality of selection means (13,14) between an enable state and a disable state of selection.

Patentansprüche

1. Aufnahmesystem, mit:

einer Vielzahl von Sensoreinheiten (3, 17), die jede ein jeweiliges fotoelektrisches Umwandlungsgerät (6) umfassen;
einer Vielzahl von Auswahleinrichtungen (13, 14), die entsprechend der Vielzahl von Sensoreinheiten angeordnet sind, jeweils zum Auswählen der entsprechenden jeweiligen Sensoreinheiten; und
einer Steuereinrichtung (7) zur Überwachung von Signalen (SW_sg1, SW_sg2) von jeweiligen Auswahleinrichtungen (13, 14);

wobei die Steuereinrichtung (7) als Reaktion auf ein Signal (SW_sg1; SW_sg2) von einer beliebigen ausgewählten Auswahleinrichtung der Vielzahl von Auswahleinrichtungen (13, 14), die entsprechend ihrer jeweiligen ausgewählten Sensoreinheit (3; 17) angeordnet ist, dahingehend ausgestaltet ist, um an diese jeweilige Sensoreinheit (3; 17) einen Befehl (Cmd1; Cmd2) zu übertragen, um das jeweilige fotoelektrische Umwandlungsgerät von einer Nichtverwendungsbetriebsart in eine Verwendungsbetriebsart zu schalten, und um an eine andere Sensoreinheit (17; 3), deren fotoelektrisches Umwandlungsgerät (6) sich in einer Verwendungsbetriebsart befindet, einen Befehl (Cmd2; Cmd1) zu übertragen, um das fotoelektrische Gerät von einer Verwendungsbetriebsart in eine Nichtverwendungsbetriebsart zu schalten.

2. System nach Anspruch 1, wobei die Steuereinrichtung (7) dahingehend ausgestaltet ist, um die jeweilige ausgewählte Sensoreinheit (3; 17) in einen Energieeinschaltzustand in der Verwendungsbetriebsart zu setzen, in welchem die jeweilige ausgewählte Sensoreinheit (3; 17) mit Energie versorgt wird, und um die andere Sensoreinheit (17; 3) in einen Energieausschaltzustand in der Nichtverwendungsbetriebsart zu setzen, in welchem die andere Sensoreinheit (3; 17) nicht mit Energie versorgt wird.

3. System nach Anspruch 1, wobei die Steuereinrichtung (7) dahingehend ausgestaltet ist, um das fotoelektrische Umwandlungsgerät in einen normalen Stromzustand in der Verwendungsbetriebsart und in einen geringen Stromzustand in der Nichtver-

wendungsbetriebsart zu setzen.

4. System nach einem der vorangehenden Ansprüche, zudem mit einer elektromagnetischen Wellenerzeugungseinrichtung (1) zur Bestrahlung der jeweiligen ausgewählten Sensoreinheit (3; 17) mit einer elektromagnetischen Welle, und wobei die Erzeugungszeit der elektromagnetischen Welle gemäß der elektromagnetischen Wellendosis gesteuert wird.

5. System nach Anspruch 4, wobei jede der Vielzahl von Sensoreinheiten einen Photozeitgeber (15, 16) aufweist, welcher an die elektromagnetische Wellenerzeugungseinrichtung (1) ein Signal ausgibt, und wobei die elektromagnetische Wellenerzeugungseinrichtung (1) betreibbar ist, um eine Erzeugung der elektromagnetischen Welle gemäß der Signalmenge des Ausgabesignals auszuschalten.

6. System nach Anspruch 5, wobei die Steuereinrichtung (7) eine Einrichtung zur Auswahl des Fotozeitgebers (15, 16) der jeweiligen ausgewählten Sensoreinheit (3; 17) aufweist.

7. System nach einem der vorangehenden Ansprüche, wobei die Steuereinrichtung (7) eine Einrichtung zur Schaltung jeder der Vielzahl von Auswahleinrichtungen (13, 14) zwischen einem Freigabezustand und einem Nichtfreigabezustand einer Auswahl aufweist.

Revendications

1. Système capteur comportant:

une pluralité d'unités à capteurs (3, 17) comprenant chacune un appareil respectif de conversion photoélectrique (6);
une pluralité de moyens de sélection (13, 14) agencés en correspondance avec ladite pluralité d'unités à capteurs, respectivement pour sélectionner les unités à capteurs respectives correspondantes; et
un moyen de commande (7) destiné à contrôler des signaux (SW_sg1, SW_sg2) provenant de moyens de sélection respectifs (13, 14);

dans lequel ledit moyen de commande (7), en réponse à un signal (SW_sg1, SW_sg2) provenant de l'un, quelconque, sélectionné (13 ; 14) de ladite pluralité de moyens de sélection (13, 14), agencé en correspondance avec son unité à capteur sélectionné respective (3; 17), est conçu pour transmettre à cette unité à capteur respective (3; 17) un ordre (Cmd1; Cmd2) pour commuter l'appareil respectif de conversion photoélectrique d'un mode de fonctionnement en non-utilisation à un mode de fonctionnement en utilisation, et pour transmettre à une autre unité à capteur (17; 3), dont l'appareil de conversion photoélectrique (6) est dans un mode de fonctionnement en utilisation, un ordre (Cmd2, Cmd1) pour commuter cet appareil photoélectrique du mode de fonctionnement en utilisation au mode de fonctionnement en non-utilisation.

2. Système selon la revendication 1, dans lequel ledit moyen de commande (7) est agencé pour établir ladite unité à capteur sélectionnée respective (3; 17) dans un état sous tension dans le mode de fonctionnement en utilisation, dans lequel ladite unité à capteur sélectionnée respective (3; 17) est alimentée en énergie, et pour établir ladite autre unité à capteur (17; 3) dans un état hors tension dans le mode de fonctionnement en non-utilisation, dans lequel ladite autre unité à capteur (17; 3) n'est pas alimentée en énergie.

3. Système selon la revendication 1, dans lequel ledit moyen de commande (7) est agencé de façon à établir l'appareil de conversion photoélectrique dans un état de courant normal dans le mode de fonctionnement en utilisation et dans un état à courant faible dans le mode de fonctionnement en non-utilisation.

4. Système selon l'une quelconque des revendications précédentes, comportant en outre un moyen (1) de génération d'onde électromagnétique destiné à irradier ladite unité à capteur sélectionnée respective (3; 17) avec une onde électromagnétique, et dans lequel le temps de génération de l'onde électromagnétique est commandé en fonction de la dose de l'onde électromagnétique.

5. Système selon la revendication 4, dans lequel chacune de ladite pluralité d'unités à capteurs comprend un photominuteur (15, 16) qui délivre en sortie un signal audit moyen (1) de génération d'onde électromagnétique, et dans lequel ledit moyen (1) de génération d'onde électromagnétique peut être mis en oeuvre pour arrêter la génération de l'onde électromagnétique conformément à la grandeur de signal dudit signal de sortie.

6. Système selon la revendication 5, dans lequel ledit moyen de commande (7) comprend un moyen destiné à sélectionner le photominuteur (15, 16) de ladite unité à capteur sélectionnée respective (3; 17).

7. Système selon l'une quelconque des revendications précédentes, dans lequel ledit moyen de commande (7) comprend un moyen destiné à commuter chacun de ladite pluralité de moyens de sélection (13, 14) entre un état de validation et un état d'in-

validation de la sélection.

FIG. 1

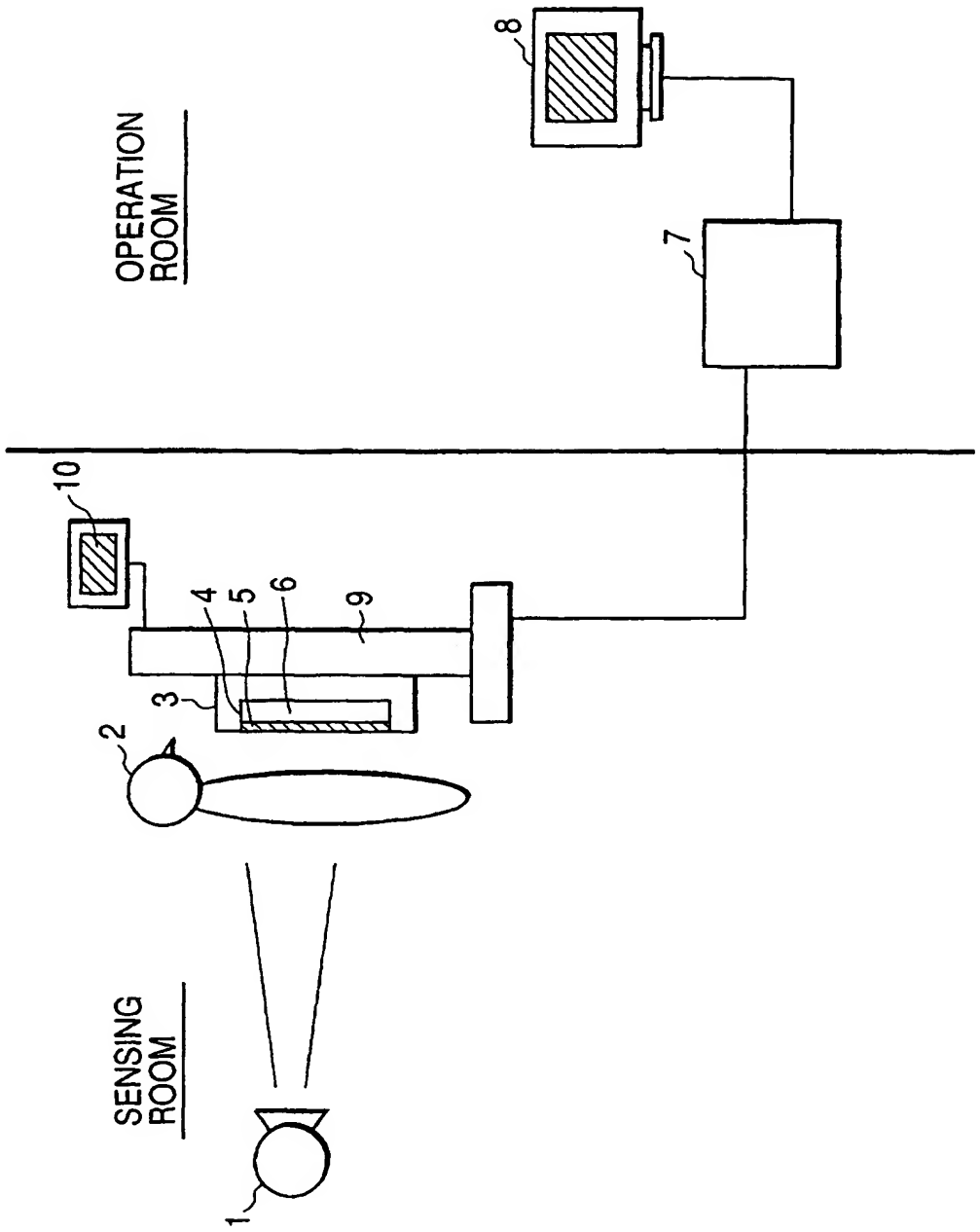

FIG. 2

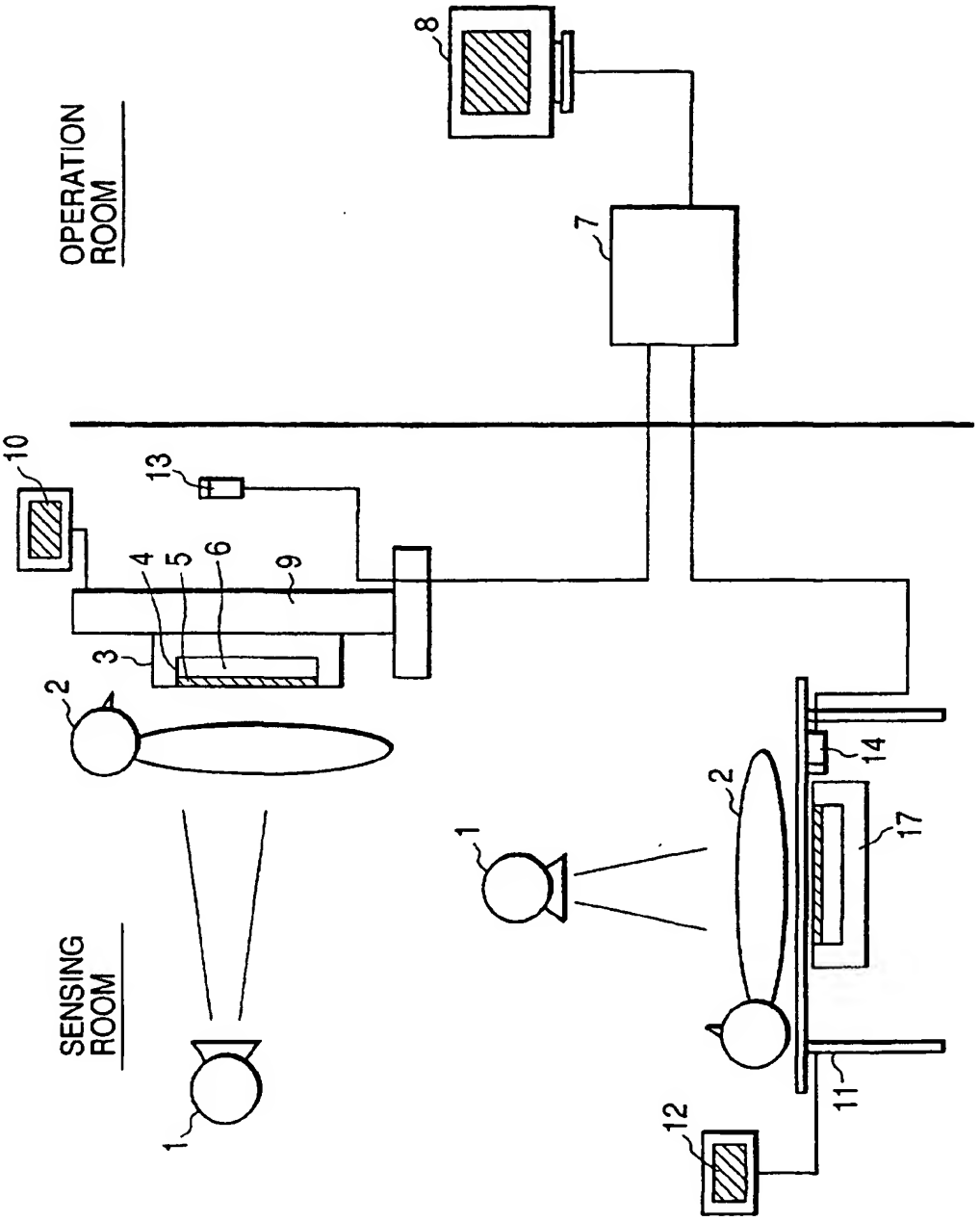

FIG. 3

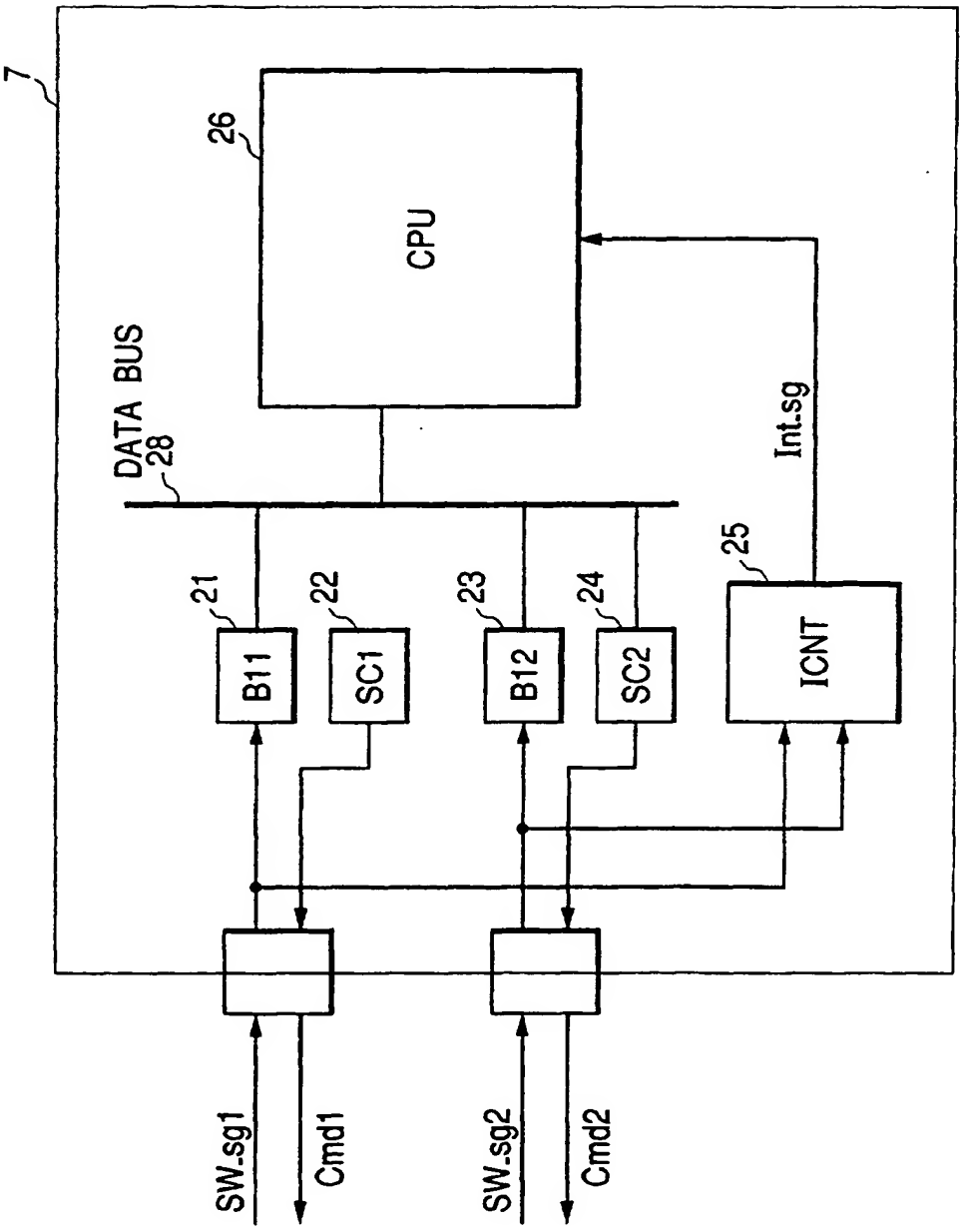
7
26
CPU
DATA BUS
28
Int.sg
25
21
22
23
24
B11
SC1
B12
SC2
ICNT
SW.sg1
Cmd1
SW.sg2
Cmd2

FIG. 4

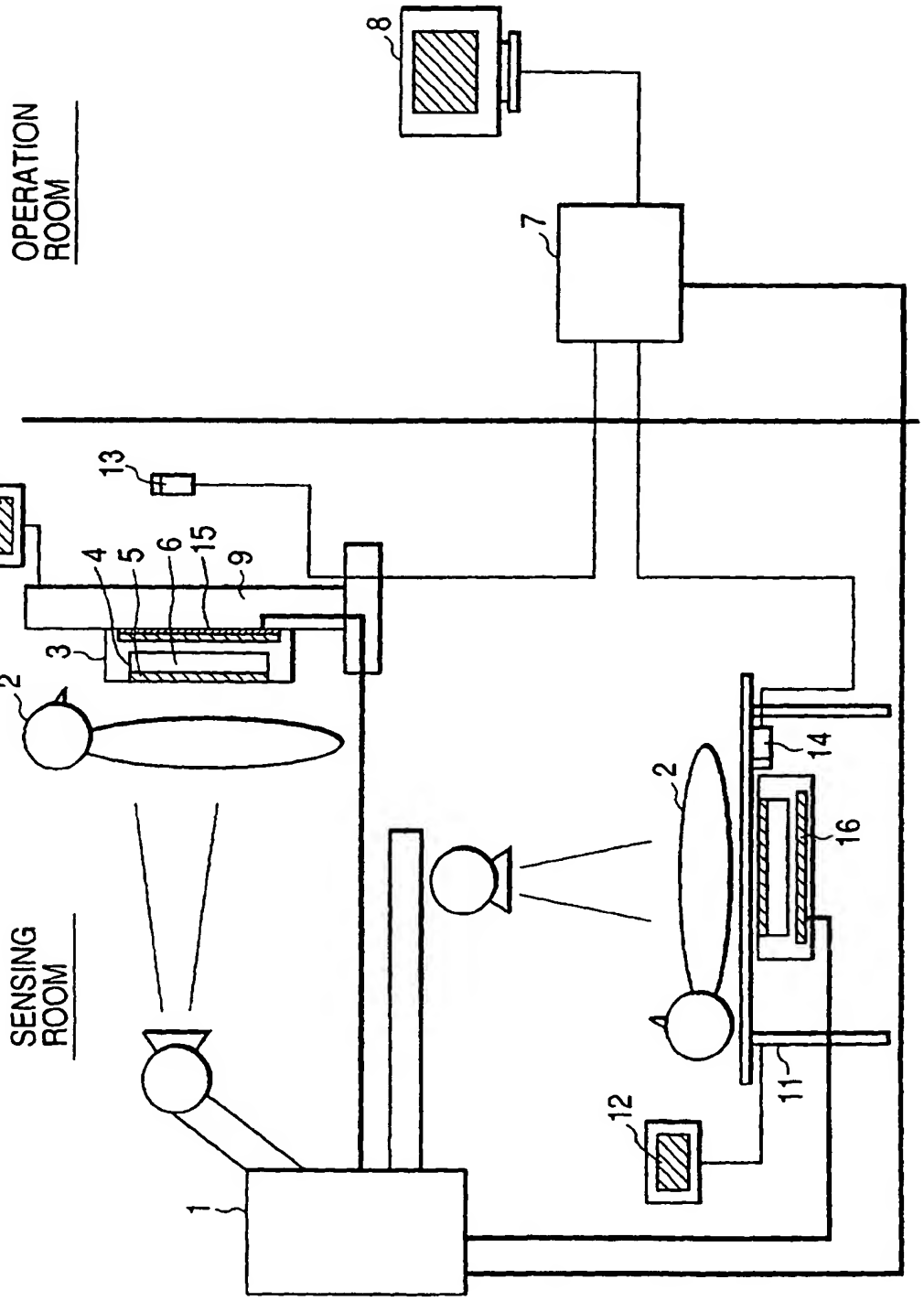

FIG. 5

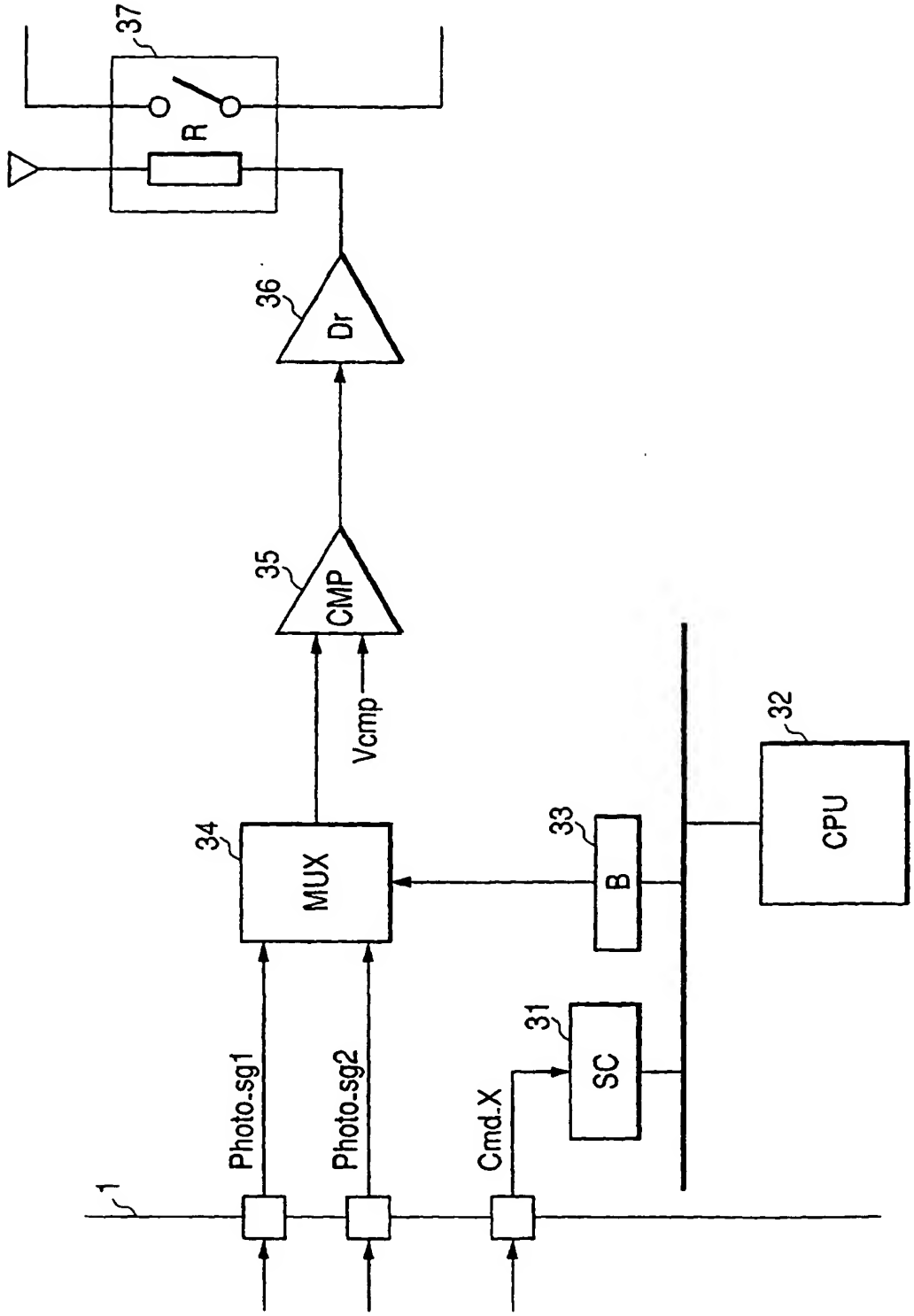
37
R
36
Dr
35
CMP
Vcmp
34
MUX
33
B
32
CPU
31
SC
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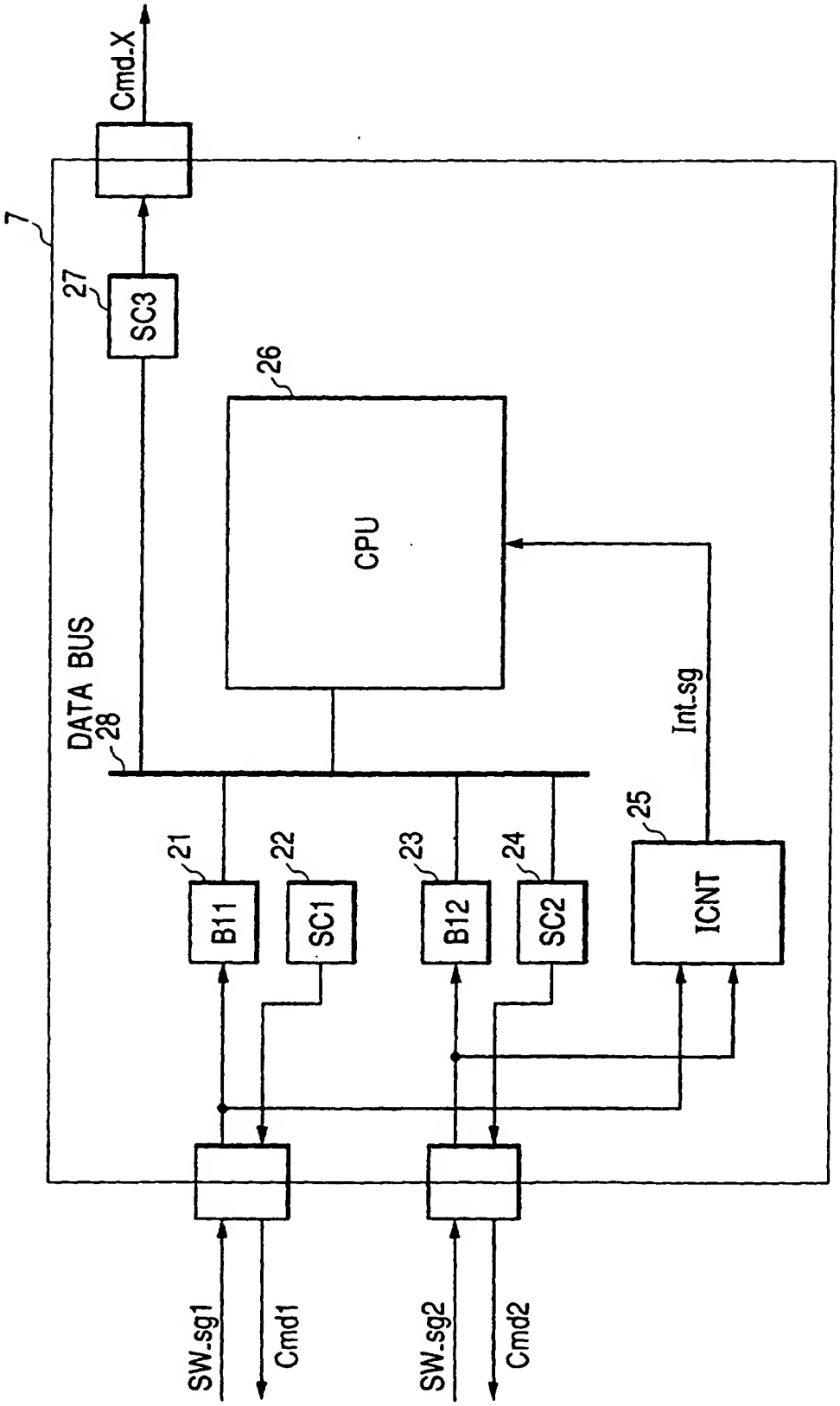
Photo.sg2
Cmd.X
1

FIG. 6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27
SC3
26
CPU
DATA BUS
28
Int.sg
25
21
22
23
24
B11
SC1
B12
SC2
ICNT
SW.sg1
Cmd1
SW.sg2
Cmd2

FIG. 7